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Biodiesel production potential from edible oil seeds in Iran

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ABSTRACT

Biodiesel can be considered as the optimum alternative fuel for diesel fuel in Iran. Biodiesel is an environmentally friendly fuel and has the potential to provide comparable engine performance results. The biodiesel production potential from oil seeds such as canola, soybean, cotton, seasem, olive, sunflower, safflower, almond, corn, coconut, walnut and hazelnut in Iran is investigated in this paper. In Iran, oil seeds are not commonly used for energy application. This is because; more than 90% of the edible oil for human consumption is being imported. To contribute to the fuel supply, renewable energies such as oil seeds to be an attractive resource for biodiesel production, this paper aims to cover several perspectives on the size of the biodiesel oil seeds resource in Iran. Oil seeds are harvested every year in Iran. Around 1 million ha of land from 20 states are estimated to be potential land for growing of oil seeds. There are approximately 3.67 MT (million ton) of oil seeds crops in Iran that can potentially produce 721 ML (million liter) of biodiesel every year. Canola, cotton and soybean are the most favorable biodiesel production source. Based on the results, it can be concluded that production of biodiesel from the seed oils can ideally replace about 2% of total diesel fuel consumption in Iran. By managing this, an B2 (2% biodiesel and 98% diesel) can be an optimum alternative fuel for compressed ignition engine since there is no major engine modification required to use biodiesel.

Contents

1. Introduction

Developing renewable energy has become an important part of worldwide energy policy to reduce greenhouse gas emissions caused by fossil fuels [1]. Alternative transport fuels such as hydrogen, natural gas and biofuels are seen as an option to help the transport sector in decreasing its dependency on oil and reducing its environmental impact [2,3]. Between 2001 and 2006, the global production of biofuels (biodiesel and bioethanol) grew by 43% and 23%, respectively [1,4]. In 2007, the annual world total production of bioethanol was estimated to be 45 billion liters, while the annual production of biodiesel was approximately 5 billion liters [4–6]. The production of biofuels indicates a new economic opportunity for different countries especially for Asia. Scientists have studied the possibility of biofuels production in Asian countries. In 2009, Phalan studied the social and environmental impacts of biofuels in Asia and indicated that biofuels will form a small but significant part of Asia's energy supply in the coming decades [7]. Bio-methanol potential in Indonesia was investigated by Suntana et al. [8]. In 2009, optimizing biodiesel production in India was studied by Leduc et al. [9]. Bioethanol development in China and the potential impacts on its agricultural economy was studied by Qiu et al. in 2010 [10]. Some scientists studied the possibility of bioethanol and biodiesel production in different countries of Asia [11–14]. The results of these studies prove that several countries in the Asia regions have different plants to produce biofuels in order to enhance energy security and development. This paper investigates biodiesel production possibility in Iran. Primary energy demand in Iran is projected to increase at an average annual rate of 2.6% in 2003–2030, down from around 5% over the past decade. This assumes that the progressive removal of energy subsidies, now equivalent to a staggering 10% of GDP (gross domestic product). Iran's oil reserves are the second largest in the Middle

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East, after Saudi Arabia. Oil production is projected to grow from 481.13 ml/d (million liters per day) in 2004 to 528.07 ml/d in 2010 and to 798 ml/d in 2030. Iran holds the second largest natural gas reserves in the world. Gas production which is expected to grow to 110 bcm (billion cubic meters) in 2010 and to 240 bcm in 2030. Electricity generation is estimated to be increased from 153 TWh (terra watt hour) in 2003 to 359 TWh in 2030, requiring 54 GW of new generating capacity and total investment in power infrastructure of $92 billion [3]. The growth of Iran's economy has been the cause of increase in energy consumption and despite the growth of domestic energy production; demand has grown even faster especially in the fossil fuels sector. If this increasing trend continues, it will be clear that in future, Iran shifts from being a minor exporter to being a major importer. As it mentioned, the major rise in energy import has come from the increased gasoline and diesel fuels consumption in transportation. In 2009, Iran consumed 31,800 million liter of diesel fuel in the transport sector [3]. One of the good scenarios for decreasing of fuels consumption is planning to produce and consume biofuels. For this reason, Iran government needs to prepare its biofuel development plan and serious supporting policies. Renewable energy resources do not have wide applications in Iran at present and even in 2030, while the fossil fuels consumption will increase. The use of renewable energy, especially biofuels will make Iran stand for a better chance to have share of energy from non-fossil energy sources, and it will surely decrease the fossil fuel consumption. In Iran, biofuel has great potential to improve energy services based on agricultural materials [5]. The Iranian energy demand is expected to grow over the next couple of decades. Another concern is about the environmental pollution which is growing due to the increase of the use fossil fuels. A number of development activities are being taken up in Iran for the production of bioethanol and biodiesel which include study of using 5% ethanol as a blend in 95% of gasoline for using in passenger cars and also study of biodiesel production methods from different sources, production of biodiesel and using of biodiesel and diesel blended fuel in diesel engines [15–18]. These studies are ongoing in various states. This paper shows that there is a considerable potential for utilization of oil seeds in Iran in order to produce biodiesel. Producing biodiesel from the edible oil seeds can ideally replace approximate 2% of total diesel fuel consumption in this country. By managing this oil seeds, a B2 (blend with 2% biodiesel and 98% diesel fuel) can be an optimum alternative fuel for CI engine since there is no major engine modification required to use B%. The authors strongly recommend these techniques so that Iran can reduce its import of diesel fuel. There is no doubt that, there is a substantial need for more research to study the other economic issues related to biofuels specially biodiesel for the Iranian situation.

2. Potential of biodiesel production from edible oil in Iran

Oil seeds are harvested manually every year in Iran. Around 1 million ha of land from 20 states are estimated to be potential land for growing of oil seeds (Fig. 1). These states were studied and after analyzing of data it was found that there are approximately 3.67 MT (million ton) of oil seeds crops in Iran that can potentially produce 721 ML (million liter) of biodiesel every year. Canola, cotton and soybean are the most favorable biodiesel production sources in Iran. Figs. 2–7, show the shares of the individual states to the region's canola, cotton and soybean cultivate area and the share of production for these oil seeds in different states, respectively.

Seasem, olive, sunflower, safflower, almond, corn, coconut are also the other potential oilseeds for biodiesel production in Iran. These crops are grown in most of the provinces in Iran and could be considered as a part of the policies for potential source of biodiesel. Fars, Khuzestan and Khorasan are the major oilseeds production provinces. The identified states with their area for plantation of other oilseeds in 2007–2008, are presented in Figs. 8 and 9.

According to Fig. 1, it is possible to grow oilseeds in most of the provinces in Iran. They are mainly distributed in the north, north-

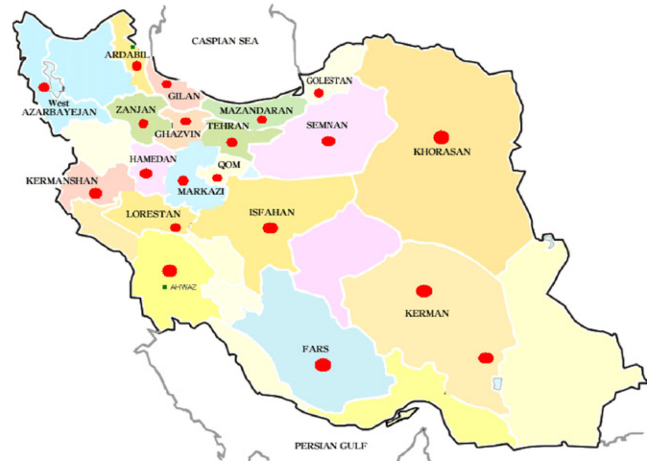


Fig. 1. The identified states for plantation of oil seeds in Iran.

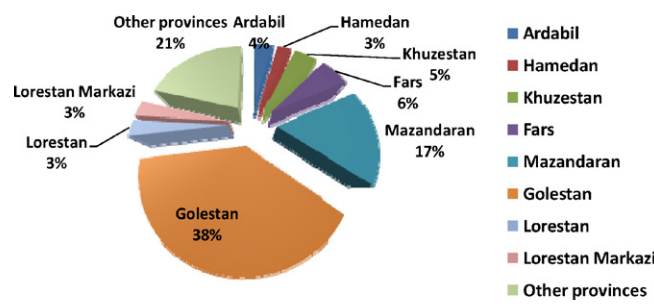


Fig. 2. The identified states with their area for plantation of Canola in 2007–2008 in Iran [19,20].

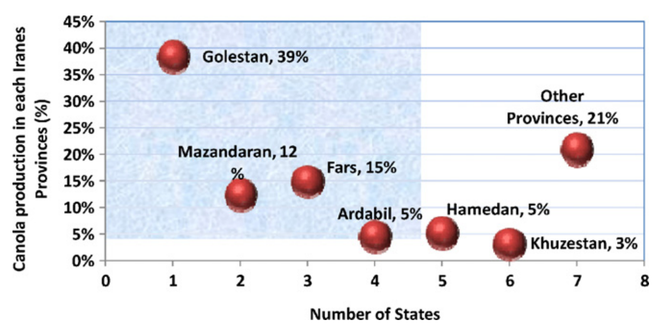


Fig. 3. Canola production in Iran, different states [19,20].

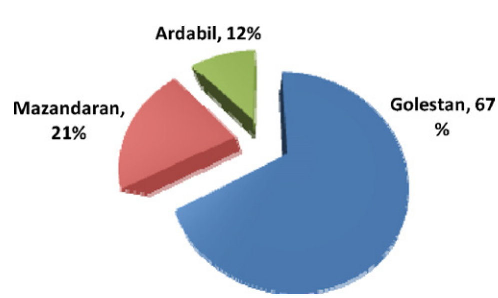


Fig. 4. The identified states with their area for plantation of Soybean in 2007–2008 in Iran [19,20].

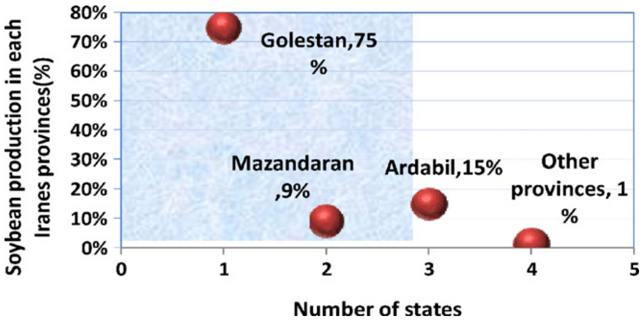


Fig. 5. Soybean production in Iran, different states [19,20].

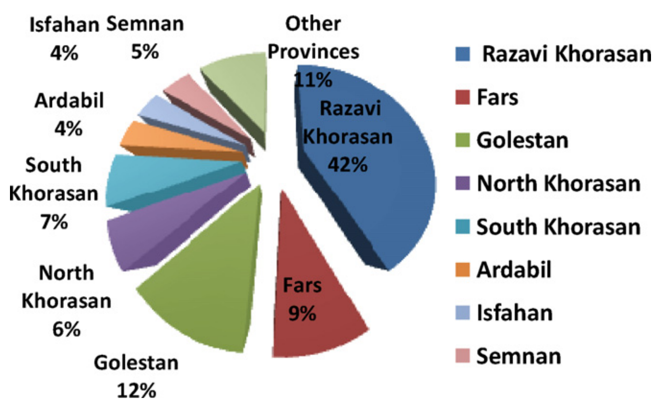


Fig. 6. The identified states with their area for plantation of Cotton in 2007–2008 in Iran [19,20].

west, east and the central Iran with the total area of 1,068,831.2 ha (Table 1). Table 1 depicts that total production of oilseeds in Iran was 3,678,540.43 ton, and total potential can be 721,052 ton/year. The regions with higher potentials are the states in the north of Iran. Fig. 10 shows the capacity of biodiesel production from different edible oilseeds in Iran. It is clear from Fig. 10 that, canola, soybean, cotton, almond, corn and walnut have more potential for production of biodiesel.

3. Discussion and conclusions

Oilseeds have potential as an alternative energy source. However, biodiesel that is produced from oilseeds will not solve Iran's dependence on foreign diesel fuel. Use of these alternative energy sources will contribute to a more stable supply of energy. For reaching this purpose, government must support these types of projects. This paper showed that there is a considerable potential for utilization of oilseeds as biodiesel production source in Iran.

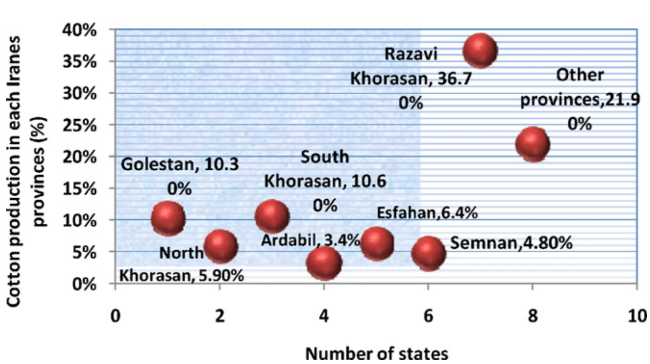


Fig. 7. Cotton production in Iran, different states [19,20].

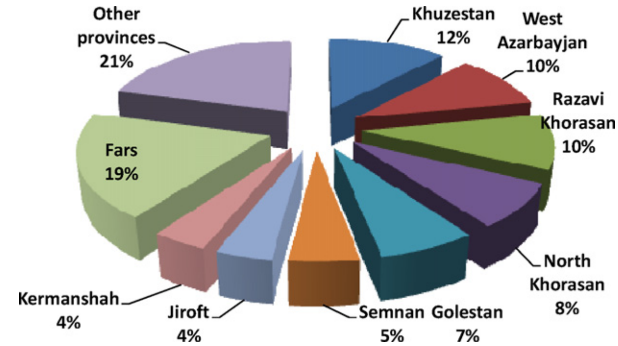


Fig. 8. The identified states with their area for plantation of other oilseeds in 2007–2008 in Iran [19,20].

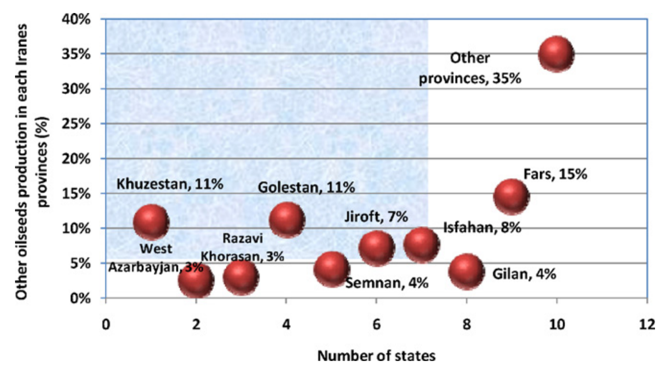


Fig. 9. The other oil seeds production in Iran, different states [19,20].

Table 1
Biodiesel production potential from major edible oil seeds in Iran in 2007–2008 [19,20].

No.	Oil seeds	Total area (ha)	Production (ton)	Oil content (%)	Yield (biodiesel (ton/year))
1	Canola	169,160	356,890.36	40	142,756
2	Soybean	74,993	178,818.19	20	34,764
3	Cotton	124,524	312,966.48	20	62,593
4	Seasem	40,000	34,368	50	17,184
5	Olive	95,044.3	61,338.65	20	12,268
6	Sunflower	23,980	21,221	50	10,610
7	Safflower	4,622	4,557	32	1,458
8	Almond	50,496.65	81,320.15	55	44,726
9	Corn	306,925	2,361,298.52	10	236,129
10	Coconut	3	10	70	7
11	Walnut	169,607.05	247,863.48	60	148,718
12	Hazelnut	9,476.2	17,888.6	55	9,839
Total		1,068,831.2	3,678,540.43	–	721,052

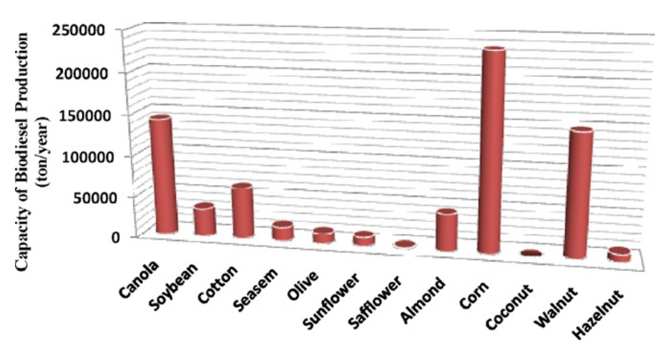


Fig. 10. Major edible oil seeds for production of biodiesel in Iran 2007–2008.

Around 1 million ha of land from 20 states are estimated to be potential land for growing oil seeds. There are approximately 3.67 MT (million ton) of oil seed crops in Iran that can potentially produce 721 ML (million liter) of biodiesel every year. Canola, cotton and soybean are the most favorable biodiesel production source in Iran. Based on the results, it was concluded that production of biodiesel from the seed oils can ideally replace about 2% of total diesel fuel consumption in Iran. Considering a suitable management, a B2 (2% biodiesel and 98% diesel) can be an optimum alternative fuel for CI engine since there is no major engine modification required to use biodiesel.

The authors of this paper are strongly recommended these techniques, so Iran can reduce import diesel fuel. There is no doubt that, there is a substantial need for more research to study the other economic issues related to biofuels specially biodiesel.

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References

[1] Birur DK, Hertel TW, Tyner WE. The biofuels boom: implications for world food markets. In: Food economy conference. 2007.
[2] Najafi G, Ghobadian B, Tavakoli T, Buttsworth DR, Yusaf TF, Faizollahnejad M. Performance and exhaust emissions of a gasoline engine with ethanol blended gasoline fuels using artificial neural network. Applied Energy 2009;86: 630–9.
[3] Ghobadian B, Najafi G, Rahimi H, Yusaf TF. Future of renewable energies in Iran. Renewable and Sustainable Energy Reviews 2009;13:689–95.
[4] Biofuels in Asia. Applied Energy 2009;86:S1–10.
[5] Najafi G, Ghobadian B, Tavakoli T, Yusaf T. Potential of bioethanol production from agricultural wastes in Iran. Renewable and Sustainable Energy Reviews 2009;13:1418–27.
[6] BP. Statistical review of world energy 2009. BP; 2009.
[7] Phalan B. The social and environmental impacts of biofuels in Asia: an overview. Applied Energy 2009;86:S21–9.
[8] Suntana AS, Vogt KA, Turnblom EC, Upadhye R. Bio-methanol potential in Indonesia: forest biomass as a source of bio-energy that reduces carbon emissions. Applied Energy 2009;86:S215–21.
[9] Leduc S, Natarajan K, Dotzauer E, McCallum I, Obersteiner M. Optimizing biodiesel production in India. Applied Energy 2009;86:S125–31.
[10] Qiu H, Huang J, Yang J, Rozelle S, Zhang Y, Zhang Y, et al. Bioethanol development in China and the potential impacts on its agricultural economy. Applied Energy 2010;87:76–83.
[11] Matsumoto N, Sano D, Elder M. Biofuel initiatives in Japan: strategies, policies, and future potential. Applied Energy 2009;86:S69–76.
[12] Prabhakar SVRK, Elder M. Biofuels and resource use efficiency in developing Asia: back to basics. Applied Energy 2009;86:S30–6.
[13] Balat M, Balat H. Progress in biodiesel processing. Applied Energy 2010;87:1815–35.
[14] Zhang C, Xie G, Li S, Ge L, He T. The productive potentials of sweet sorghum ethanol in China. Applied Energy 2010;87:2360–8.
[15] Kiani Deh Kiani M, Ghobadian B, Tavakoli T, Nikbakht AM, Najafi G. Application of artificial neural networks for the prediction of performance and exhaust emissions in SI engine using ethanol-gasoline blends. Energy 2010;35:65–9.
[16] Ghobadian B, Rahimi H, Nikbakht AM, Najafi G, Yusaf TF. Diesel engine performance and exhaust emission analysis using waste cooking biodiesel fuel with an artificial neural network. Renewable Energy 2009;34:976–82.
[17] Rahimi H, Ghobadian B, Yusaf T, Najafi G, Khatamifar M. Diesterol: an environment-friendly IC engine fuel. Renewable Energy 2009;34:335–42.
[18] Najafi G, Yusaf TF, Ghobadian B, Najmeddin VR, Yousif BF. Performance and exhaust emission of a SI engine fuelled with potato waste ethanol and its blends with gasoline. International Energy Journal 2009;10:215–26.
[19] Information and statistics department of agricultural ministry of Iran, www.agri_jahad.ir.
[20] http://agriculturist.blogfa.com.